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Electro-Optic Deflectors as a Method of Beam Smoothing for Inertial Confinement Fusion

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ABSTRACT

In recent research,[1] an electro-optic deflector (EOD) has been investigated for use as a beam smoothing method for ICF. The principle of operation is to impose a time varying angular deflection on the beam by applying a time varying field gradient across an electro-optic crystal. In a manner similar to the smoothing by spectral dispersion method (SSD),[2] which also generates beam deflection (by phase modulation and spectral dispersion), the EOD can shift and smooth the speckle pattern generated on the target by a phase plate and focusing lens.

The EOD is an attractive solution to the smoothing problem in that the gratings required for SSD are eliminated. However, analysis shows that in direct comparison to an optimized SSD beam smoothing system the beam divergence obtained with an EOD system using equal peak (sinusoidal) phase modulation is at best smaller by a factor of π. This reduced divergence translates into poorer asymptotic smoothing performance at equal peak phase modulation, as seen in Fig. 1. This comparison shows that the asymptotic effective number of averaged speckle patterns (the inverse of the normalized variance σ^2) obtained with the EOD is smaller by a factor of ~ 2.4 compared with 1D SSD of the same peak phase.

The reduced asymptotic performance of the EOD can be overcome by increasing its peak phase modulation. The limitation on peak phase modulation of a given modulator design will generally be determined by breakdown within the RF cavity owing to the large electric fields present. Therefore, one expects the maximum phase modulation of an EOD cavity to be similar to that of a frequency modulator (FM) cavity of similar design. In this case one expects that FM-SSD would have a better asymptotic performance limit than EOD when

similar modulators are used. Another limit on beam smoothing is imposed by the bandwidth limitations of frequency conversion in an ICF laser. Assuming equal bandwidth one can show that, for SSD and EOD systems of equal asymptotic performance, the initial smoothing rate of the EOD will be reduced in comparison to that of SSD by a factor of ~ 1.2. A detailed comparison of beam smoothing by SSD and EOD under these various conditions will be presented. This work was performed under the auspices of the U. S. Department of Energy by Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.

References

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2. S. Skupsky, *et al,* J. Appl. Phys. **66**, 3456 (1989).

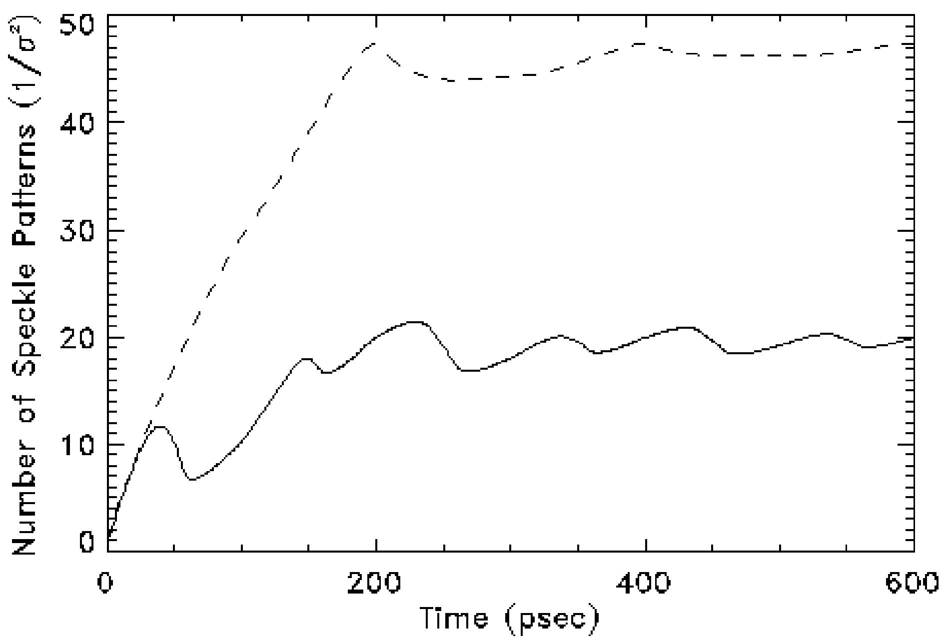

Figure 1: Effective number of speckle patterns $(1/\sigma^2)$ versus integration time using smoothing with a 1D EOD (solid curve), and 1D SSD (dashed curve). The modulation frequency is 5 Ghz and peak phase is 40 radians in both methods.